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ABSTRACT

Twenty first graders and 20 second graders in Houston, Texas, were examined on skills in segmenting, reading, and spelling 50 words with regular and exceptional spelling patterns. By using the same words for each task, it was possible to assess the interrelationships among these skills on a word by word, child by child basis. A multivariate analysis of variance was conducted on mean difference scores for segmentation-reading, segmentation-spelling, and reading-spelling. Positive differences between measures were observed, except in the segmentation-reading analysis of regular words requiring the deletion of consonant blends and medial sounds. In addition, graphical analyses showed a greater probability of correct reading and spelling given correct segmentation than incorrect segmentation. Results were interpreted to support a computational notion of phonology as a prerequisite to reading and spelling, with a more reflective notion explaining the reciprocal relation between reading and segmentation of complex spelling patterns. (Four tables and two figures of data are included; 21 references and a list of the stimuli for segmentation, reading, and spelling tests are attached.) (Author/RS)

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Links among Segmenting, Spelling, and Reading Words in First and Second Grades

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Running head: LINKS IN FIRST AND SECOND GRADES

Abstract

Twenty first graders and twenty second graders were examined on skills in segmenting, reading, and spelling 50 words with regular and exceptional spelling patterns. By using the same words for each task, it was possibloe to assess the interrelationships among these skills on a word by word, child by child basis. A multivariatew analysis of variance was conducted on mean difference scores for segmentation-reading, segmentation-spelling, and reading-spelling. Positive differences between measures were observed, except in the segmentation-reading analysis of regular words requiring the deletion of consonant blends and medial sounds. In addition, graphical analyses showed a greater probability of correct reading and spelling given correct segmentation than incorrect segmentation. Results were interpreted to support a computational notion of phonology as a prerequisite to reading and spelling, with a more reflective notion explaining the reciprocal relation between reading and segmentation of complex spelling patterns.

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It is no longer surprising to find a significant connection between children's awareness of phonological units in words and their ability to read and spell (see Adams, 1990 and Goswami & Bryant, 1990 for reviews). In fact, there are longitudinal and training studies that prove a causal connection between phonological awareness and success in reading and spelling (Bradley & Bryant, 1985; Lundberg, Frost, & Petersen, 1988). Moreover, there is converging evidence that it is a deficit in phonological skills rather than a lag in the development of phonological skills that differentiates dyslexic from poor readers (Rack, Snowling, & Olson, 1992; Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1992). However, before we rush to salvage the future of children's literacy with phonological awareness programs, we need to know more precisely which phonological unit(s) children need to be aware of--syllable, phoneme, or something in between called onset-rime (Treiman, 1985)--and exactly how awareness facilitates acquisition of reading and spelling. Accordingly, in the present investigation we asked first and second graders to segment, read, and spell the same fifty words so that on a child by child, word by word, basis we could address how ability to segment the sounds in particular words related to the way a child read and spelled those same words.

In our previous research (Foorman, Francis, Novy, & Liberman, 1991; Foorman & Francis, 1992; Foorman & Liberman, 1989), we used Rosner and Simon's (1971) *Test of Auditory Analysis Skills(TAAS)* to measure segmentation skill and our own experimental word list to measure reading and spelling skills in six classrooms of first graders receiving different amounts of letter-sound instruction. Although classrooms did not differ in *TAAS* scores collected in October, classrooms with more letter-sound instruction improved at a faster rate in correct spellings and readings. Individual growth models analysis indicated that segmentation scores obtained in October predicted overall performance in reading and spelling. Growth in segmentation scores predicted overall performance in spelling but only predicted end-of-year differences in regular and exception-word reading. Finally, better reading of regular words in October was associated with faster growth in spelling, and better spelling of regular words in October was predictive of May word reading, after conrtrolling for the facilitative effect of more letter-sound instruction on growth rate.

We interpreted these results as suggestive of a uni-directional link between segmentation and reading, in support of Bradley and Bryant (1985), and a bi-directional link between segmentation and spelling and between spelling and reading. But one concern we have about generalizing these results (and others in the literature) is that the linguistic effects on segmenting the words on the *TAAS* are bound to be different from the linguistic effects on reading and spelling words from our experimental list simply because the *TAAS* consists of different words. However, in the literature it is common practice to use different lists of words to assess phonological awareness, reading, and spelling.

Rosner and Simon's (1971) *TAAS*, based on the work of Bruce (1964), is not in fact a test of auditory analysis skills. Rather, it is a phonological test of skill in segmenting, deleting, and eliding initial, medial, and final sounds in words at the syllable and phoneme level. A sample item is "Say *carpet*, now say it again without *car*" (*pet*). Other items are the following, with the sound to be deleted noted parenthetically: *bel(t)* and *ti(me)*; *(l)end* and *(s)mile*; *cr(e)ate* and *cont(in)ent*. In each case the elided sounds result in a real English word. Rosner and Simon (1971) gave the *TAAS* to children whose ages ranged from five years to eleven years and found that number correct on the *TAAS* correlated with reading achievement. They also found that five and six year olds were better at deleting final sounds than initial sounds, a finding supported by Content, Kolinksy, Morais and Bertelson (1986) on a slightly different deletion task. Finally, Rosner and Simon confirmed Bruce's finding

that deletion of medial sounds (as second consonant in a consonant blend or middle syllable in a three-syllable word) was difficult even for the oldest children.

Critics of deletion tasks such as Rosner and Simon's claim that a child already must be able to read and spell to perform well on the task (see Adams, 1990). This may very well be true for deleting medial sounds. However, deletion of final and initial sounds may tap into computational knowledge of phonology rather than reflective knowledge of phonology (Perfetti, 1991). This computational knowledge may manifest itself as the preliterate skill that facilitates acquisition of literacy. From Goswami and Bryant's (1990) perspective, we are not speaking of deleting initial and final phonemes. Rather, we are speaking of deleting beginning and ending sounds that coincide with Treiman's (1985) intrasyllabic units of onset and rime. Indeed, on the *TAAS*, deletion of the initial consonant in a single-syllable word (e.g., *(g)ate*) is easier than splitting apart the onset (e.g., *(t)rail* or *g(l)ow*). However, the *TAAS* has no items representing rime deletion. Rime deletion is typically tapped through Bradley and Bryant's (1985) oddity task where subjects are asked to find the odd word in a sequence of words such as "hop," "rail," and "mop." Kirtley, Bryant, MacLean and Bradley (1989) found that it was much easier for five year olds to find "rail" in the above example than to find the odd word in the sequence "mop," "whip," and "lead." In other words, it is easier to delete rimes than final phonemes. However, the fact remains that young children can delete the final sounds on the *TAAS*--sounds that coincide with phonemes. Perhaps, as Goswami and Bryant (1990) suggest, they are able to do so simply by learning to "drop the end bit" of the word, a strategy that relies on crude computational knowledge of sub-syllablic parts rather than reflective knowledge of the abstract category of phoneme.

The objective of the present investigation, then, was to revise the *TAAS* to include words from our experimental word list--words with predictable and less predictable spelling patterns, called "regular" and "exceptional" here, although the variable is clearly continuous, rather than dichotomous (see Goswami & Bryant, 1990, pp. 39-42). Consistent with the view that segmentation skill is a prerequisite to reading and spelling performance, we hypothesized that for first and second grade children, segmentation performance would exceed reading and spelling performance. Accordingly, we also hypothesized that reading and spelling responses would be more advanced for words that were segmented correctly.

Method

Subjects

Forty boys and girls, half from grade 1 and half from grade 2, were selected on the basis of parental consent and Stanford Achievement Test, Form J, scores within six months of grade level. Because testing occurred at the end of the year, effort was made to limit selection to grade equivalent scores ranging from 1.6 to 2.6 for first graders, and 2.6 to 3.6 for second graders. However, the generally high reading level of students necessitated acceptance of 2 subjects in first grade and 11 subjects in second grade with scores above this range. One subject selected in second grade scored below this range. Consequently, average reading achievement scores were 2.2 in first grade and 3.6 in second grade. Subjects attended a parochial school in southwest Houston, composed of cildren from the surrounding middle class neighborhood. Seventy percent of the subjects were white, 17.5% were Hispanic, and 12.5% were black.

Materials

Fifty real English words were selected for the reading, spelling, and phonological segmentation measures: 58% were single-syllable words, 28% were two-syllable words, and 14% were three-syllable words. Of these words, 50% had regular spelling-to-sound correspondences, such as *link*, and 50% had exceptional correspondences, such as *climb*. The words were further categorized by number of

letters: single-syllable words consisted of 4-6 letters, two-syllable words consisted of 6-10 letters, and three-syllable words consisted of 6-10 letters.

Words were selected to include items appropriate for each grade level, based upon cumulative vocabulary lists for grades 1-3 in the Harcourt Brace Jovanovitch basal reading series. Items were chosen that would have a high probability of being within the spoken, but not the written vocabulary of children at each grade level. Thus, in selecting words appropriate for each grade level, words presented in the cumulative vocabulary list for that level were not included, and an attempt was made to include words presented in the vocabulary list for the next grade. Words not presented in the cumulative vocabulary lists were determined to have comparable levels of frequency of usage, as assessed by Carroli, Davies, and Richman (1971).

In addition, words were selected on the basis of Rosner and Simon's (1971) seven categories, with regular and exception words equally represented in each category: 1) omission of the final syllable of a two-syllable word; 2) omission of the initial syllable of a two-syllable word; 3) omission of the final consonant of a one-syllable word; 4) omission of the initial consonant of a one-syllable word; 5) omission of the first consonant of a consonant blend; 6) omission of a medial consonant of a consonant blend; 7) omission of a medial syllable. For purposes of analysis, these seven categories were collapsed into three categories of initial, medial, and final. (A copy of the phonological segmentation test is included in the Appendix.)

Procedure

First and second grade chidlren were group tested in the classroom by their respective teachers on their ability to spell 25 regular and 25 exception words. The spelling test was administered over the period of a week, with 10 words presented each day. Using a pencil and a piece of lined paper, numbered 1-10, the children were instructed to listen to each sound and attempt to write the letters on the paper even if they did not know how to spell a word. Each word was presented singly, as well as embedded in a sentence.

During one 30-minute individual session, each child was asked to segment each word by deleting initial, medial, or final sounds at the syllabic or phonemic levels. To demonstrate the segmentation task, the examiner showed the child an 8.5 in. x 11 in. card on which pictures of a cow and a boy's head were drawn side by side. The examiner instructed the child to say "cowboy." After the child responded, the examiner covered the picture of the boy and asked the child to say "cowboy" again, but without "boy." If the response was correct, "cow," the next demonstration item, "toothbrush," was presented using puppets, with one puppet teaching another puppet how to segment the word with the child's assistance. The same procedure was repeated for the third demonstration item, "bake." If the child failed a demonstration item, an attempt was made to teach the task by repeating the demonstration procedures. In the present study, all subjects completed the demonstration items and proceeded to the test. The experimenter pronounced the specific sound(s), not the letter name, to be omitted. If the child failed to respond to an item, it was repeated exactly as it was first stated. If the child again did not respond, an item score of zero was recorded and the next item was presented. All test items were presented.

After first and second grade children completed the segmentation task, they were shown each of the 50 words on a series of 3 in. x 5 in. cards, and asked to try to read each word. Responses to the segmentation and word reading tasks were audiotaped. Segmentation, reading, and spelling responses were scored 1 if correct and 0 if incorrect. Interrater reliability was virtually 100%.

Results

Means and standard deviations for segmentation, reading, and spelling scores are provided in Table 1. As expected, second grade scores were higher than first grade scores in reading and spelling, $F(1,38) = 14.76$ and 16.49, $p < .001$, respectively. Additionally, all subjects read and spelled the 25 regular words more accurately than the 25 exception words, $F(1,38) = 12.31$, $p < .01$ and 22.73, $p < .001$, respectively. In fact, second grade performance was near ceiling--95%--on reading aloud regular words.

Insert Table 1 about here

Analyses of Variance

Segmentation means were analyzed for effects of grade, category, and wordtype. There were significant interactions of grade x category and category x wordtype, $F(2, 37) = 3.88$, $p < .05$ and 16.32, $p < .001$, respectively. Post hoc analysis, utilizing the Bonferoni adjustment for alpha ($.05/2 = .025$), revealed grade level differences in segmenting final compared to medial sounds, $F(1, 38) = 6.43$, $p < .025$. As can be seen in Table 2, both grades were near ceiling on segmenting final sounds, with means ranging between 0 and 1. However, in segmenting medial sounds, first graders' performance was noticeably lower than second graders' (i.e., .176 vs. .424). Likewise, in the category x wordtype interaction, it was the contrast between medial and final sounds that was significant, $F(1, 38) = 8.83$, $p < .01$. From Table 2 we again note the near ceiling performance on deleting final sounds across type of word. The source of significance lies in the relative inability to delete medial sounds in exception words compared to regular words (i.e., .253 vs. .346). This difference suggests that subjects abandoned a phonological strategy and adopted a visual-orthographic strategy when deleting medial sounds. However, the visual-orthographic strategy often failed on words with less predictable spelling patterns, that is, exception words.

Insert Table 2 about here

From the means of Table 2 it appears that initial deletion was more difficult than final deletion. However, it should be pointed out that within this category performance differed for one-syllable words requiring deletion of the initial consonant in a consonant blend (e.g., (*b*)*rag*) as opposed to the initial consonant alone (e.g., (*l*)*ink*). A frequency analysis revealed that, on average, only 58% of subjects correctly deleted the initial consonant when it was part of a blend in contrast to 92% of the subjects when it was not part of a blend.

To assess the hypothesis that segmentation performance would exceed reading and spelling performance, and to examine the influence of category, wordtype and grade on the differential performance on these measures, each child's average difference score was computed for segmentation and reading, segmentation and spelling, and reading and spelling, on a word by word basis. Because responses on each variable were coded 0 for incorrect and 1 for correct, difference scores between any two variables could range from -1 to +1. A difference score of 0 would indicate that performance on the two variables was comparable. For example, a positive difference score in the analysis of segmentation-reading would indicate that, on average, segmentation exceeded reading; a negative difference score would indicate the converse. For each of the overall average difference scores, a multivariate analysis of variance with repeated measures was conducted, with grade as the between subjects factor and wordtype (regular or exception) and category (deletion of initial, medial, or final sounds) as within subjects factors. Because

category is relevant only to segmentation, it was not included as a factor in the reading-spelling analysis.

A summary of the multivariate analyses of variance with repeated measures for each pair of variables is presented in Table 3. Inspection of Table 3 reveals no significant grade level differences in overall mean difference scores for segmentation and reading, segmentation and spelling, or reading and spelling. However, there were significant interactions of grade x category and wordtype x category in the analyses involving segmentation.

Insert Table 3 about here

Observation of positive mean difference scores in Table 4 indicates that, on average, segmentation was superior to reading with exception words and with regular words requiring the deletion of final sounds. Negative mean difference scores were observed only with regular words involving deletion of initial and medial sounds. In the analysis of difference scores, there were significant effects of wordtype, $F(1, 38) = 38.75$, $p < .001$ and category, $F(2, 37) = 5.13$, $p < .01$, as well as a significant wordtype x category interaction, $F(2, 37) = 4.92$, $p < .01$. Post hoc analysis of this interaction, with Bonferoni adjustment for alpha ($.05/2 = .025$), revealed a differential effect of wordtype in the contrast of mean difference scores for words involving medial and final sounds, $F(1, 38) = 8.81$, $p < .025$. Specifically, differences between exception and regular words were maximized in deletion of medial sounds and minimized in deletion of final sounds.

Insert Table 4 about here

Positive mean difference scores were also observed in the segmentation-spelling analysis for words of both wordtypes, particularly exception words, with mean difference scores of .190 for regular words and .357 for exception words. The wordtype effect was significant, $F(1, 38) = 7.03$, $p < .01$. Although a significant category x grade interaction was observed, $F(2, 37) = 4.54$, $p < .05$, post hoc analysis indicated no significant grade level differences between the contrasts of interest: initial versus final; medial versus final; and initial versus medial sound deletion. The significant effect of category, $F(2, 37) = 13.32$, $p < .001$, was due to the fact that the segmentation-spelling difference was greater (i.e., mean of .478) for words involving final sound deletion in contrast to medial sound deletion (i.e., mean of .047).

In addition, positive mean difference scores were noted in the reading-spelling analysis of words of both wordtypes. There were no significant effects of wordtype or grade ($p > .05$).

Graphical Analyses

To examine the hypothesis that reading and spelling responses would be more advanced for children who could segment the words, Figure 1 (exception words) and Figure 2 (regular words) depict the conditional probability of correctly reading and spelling a particular word given correct or incorrect segmentation of that same word for grades 1 and 2. For example, in the upper lefthand plot of Figure 1, the conditional probability of correct spelling (x axis) given incorrect segmentation is plotted against the conditional probability of correct reading (y axis) given incorrect segmentation of exception words. Squares represent first graders and pluses represent second graders. Some random noise has been introduced to reduce overplotting, a technique known as jittering (Chambers, Cleveland, Kleiner & Tukey, 1983).

Insert Figures 1 and 2

These plots reveal that when correct reading and spelling is considered, a similar pattern is evident regardless of segmentation response to that word. In all eight plots of Figures 1 and 2, if an imaginary line is drawn at a 45° angle between the x and y axes, the clustering of symbols above the line indicates that there is a greater probability of correct reading than correct spelling given either correct or incorrect segmentation for grades 1 and 2. In addition, regardless of segmentation response, there is a greater probability of correct reading and spelling performance for second graders than first graders, reflected by the slightly greater incidence of symbols for grade 2 above a probability value of .50 on the x and y axes given correct or incorrect segmentation. Importantly, there is a greater probability of correct reading and spelling given correct segmentation, as indicated by the slightly greater incidence of symbols above a probability value of .50 along the x and y axes for correct segmentation than incorrect segmentation.

Discussion

To examine the relations among phonological segmentation, reading, and spelling, two hypotheses were assessed:

1. Phonological segmentation would exceed reading and spelling performance.
2. Reading and spelling performance would be more advanced for words segmented correctly.

First and second graders were asked to segment, read, and spell the same 50 words so that analyses could be conducted on a word by word, child by child basis. Two types of analyses were performed--analyses of mean difference scores by grade for segmentation, reading, and spelling and graphical analyses of the conditional probabilities of correct or incorrect performance among these measures.

Analyses of mean difference scores for segmentation, reading, and spelling revealed no significant differences between grades. There were, however, significant differences between type of word and category of segmentation. The wordtype effect was due to the relative ease of segmenting, reading, or spelling words with regular spelling-to-sound correspondences, such as *link*, compared to words with exceptional correspondences, such as *climb*.

The category effect in the analyses concerning segmentation was explained by the fact that differences were maximized when final sounds were deleted and minimized when medial sounds were deleted. These category effects support the difficulty of medial sound deletion (Bruce, 1964; Rosner & Simon, 1970). In this modification of Rosner and Simon's (1970) Test of Auditory Analysis Skills, medial sound deletion involved deleting the middle syllable in a three-syllable word (e.g., *ca*(*na*)*ry*) or deleting the second phoneme in a consonant blend (e.g., *s*(*p*)*ite*). In contrast, final sound deletion involved deleting a final syllable in a two-syllable word (e.g., *cap*(*tain*)) or deleting the final phoneme in a word (e.g., *bor*(*n*). The advantage of having an orthographic image to work off of when deleting medial sounds is obvious. In other words, prior ablity to read or spell a word is an enormous advantage when it comes time to aurally segment medial sounds in that word.

In these results deletion of initial sounds fell mid-way in difficulty between deletion of final sounds and deletion of medial sounds. Nearly all subjects deleted initial consonants in a single syllable word correctly. However, just a little over half the children in each grade deleted the initial consonant of a blend correctly. Again, prior ability to read or spell a word would provide a useful orthographic image as the child tried to segment the blend in a spoken word. It is informative that when these first and second graders made errors in deleting the initial or second consonant in a blend, they tended to produce the rime of the word. For example, when asked to say "crib" without the /k/, they tended to say "ib." When asked to say "swing" without the /w/, they tended to say "ing." These kinds of errors lend support to Goswami and Bryant's (1990) claim that beginning readers do as well as they do

on Rosner and Simon's (1971) test because they adopt a strategy of dropping either the initial or ending sounds. These units correspond to Treiman's (1985) intrasyllabic divisions of onset and rime, and are for Goswami and Bryant (1990) the orthographic/phonological units most predictive of success in reading and spelling.

Finally, the hypothesis that reading and spelling responses would be more advanced for words segmented correctly was explored. It was found that, indeed, when words were segmented correctly, there was a greater probability that they would be read and spelled correctly than incorrectly, and the converse was apparent, as well.

In conclusion, the link between the way beginning readers segment a word and the way they read or spell that word is clearly dependent upon the category of sound to be deleted and the adequacy of their orthographic representation. Results of this investigation are consistent with the view that awareness of beginning and ending sounds is a prerequisite to reading and spelling, but that awareness of medial sounds and consonant blends is a consequence of reading and spelling. We use "beginning sound" and "ending sound" advisedly because it is not clear to us that these children have phonemic awareness. They appear to have a sub-syllabic awareness akin to, if not the same as, Treiman's (1985) notion of onset-rime. The initial consonant deletions in this study are, in fact, onsets and, although children were not asked to delete rimes, the errors they produced on deletion of consonant blends were rimes. Therefore, we conclude that the phonological activities most facilitative to beginning reading and spelling would be at the level of onset and rime. Such activities might consist of alliterative and rhyming games. Indeed, Bryant and his colleagues (MacLean, Bryant & Bradley, 1987; Bryant, Bradley, MacLean & Crossland, 1989) found that three year olds' knowledge of nursery rhymes was related to their sensitivity to rhyme two years later. However, we do not exclude the value of phonological activites involving deletion of final phonemes. Clearly beginning readers can segment and delete final sounds that are, in fact, phonemes. And clearly they can do so for the beginning sounds--onsets--that are phonemes as well. It may be that it is this crude computational, rather than reflective, knowledge of phonemes that fuels the bi-directional link between phonology and spelling, a link that supports the development of an alphabetic strategy for reading (see Frith, 1985).

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Appendix
Stimuli for Segmentation, Reading, and Spelling Tests

(Segment of word to be deleted is within parentheses)

1. (yel)low
2. (pea)nut
3. (tip)toe
4. (see)saw
5. (work)men
6. (no)thing
7. (some)thing
8. star(fish)
9. mail(box)
10. sun(burn)
11. be(come)
12. for(ward)
13. cap(tain)
14. hand(some)
15. fir(m)
16. bor(n)
17. li(me)
18. buil(d)
19. bow(l)
20. bur(y)
21. swor(d)
22. (h)old
23. (d)ae
24. (l)ink
25. (m)eet
26. (p)rey
27. (b)reak
28. (ch)rome
29. (b)rag
30. (f)lock
31. (c)rib
32. (g)lobe
33. (c)limb
34. (sh)oes
35. (sp)read
36. b(l)ank
37. s(p)ite
38. s(w)ing
39. wor(l)d
40. ph(r)ase
41. p(l)aid
42. g(r)eat
43. ca(na)ry
44. fan(ta)sy
45. hos(pi)tal
46. col(on)ies
47. no(vel)ty
48. worr(ied)ly
49. bur(gun)dy
50. per(son)al

Table 1

Mean Number of Words Correct for Grades 1 and 2

Grade		Measure: Phonological Segmentation	Reading	Spelling
			Regular Words	
1	M	16.05	20.65	10.10
	Mean percentage	64.00	83.00	40.00
	SD	03.68	03.01	03.88
2	M	18.65	23.85	14.85
	Mean percentage	75.00	95.00	60.00
	SD	03.20	02.01	05.19
			Exception Words	
1	M	14.40	17.75	04.10
	Mean percentage	58.00	71.00	16.00
	SD	03.66	03.86	03.13
2	M	17.35	21.60	09.80
	Mean percentage	70.00	86.00	39.00
	SD	02.70	03.12	04.79

Table 2

Segmentation Means and Standard Deviations as a Function of Grade, Category, and Word Type

	Category		
	Initial	Medial	Final
Grade			
Grade 1			
Mean	.727	.176	.888
SD	.185	.169	.223
Grade 2			
Mean	.776	.424	.954
SD	.188	.224	.061
Word Type			
Regular			
Mean	.783	.346	.921
SD	.185	.267	.185
Exception			
Mean	.719	.253	.922
SD	.219	.227	.159

Table 3

Multivariate Analysis of Variance with Repeated Measures

	Phonemic Segmentation-Reading		Phonemic Segmentation-Spelling		Reading-Spelling	
Source	df	F	df	F	df	F
Between Subjects						
Grade	1,38	1.41	1,38	2.47	1,38	1.73
Within Subjects						
Wordtype	1,38	38.75***	1,38	7.03**	1,38	3.92
Category	2,37	5.13**	2,37	13.32***	2,37	N/A
Wordtype x Grade	1,38	1.10	1,38	0.56	1,38	0.26
Category x Grade	2,37	1.66	2,37	4.54*	2,37	N/A
Wordtype x Category	2,37	4.92**	2,37	1.37	2,37	N/A
Wordtype x Category x Grade	2,37	0.32	2,37	0.06	2,37	N/A

*$p < .05$

**$p < .01$

***$p < .001$

Table 4

Mean Difference Scores for Phonological Segmentation and Reading with Words Grouped According to Wordtype and Category

	Wordtype		
	Regular	Exception	
Category	Mean	Mean	Mean Total
Initial	-0.110	0.228	0.059
Medial	-0.450	0.343	-0.054
Final	0.004	0.187	0.100
Mean Total	-0.185	0.253	

Note. Positive mean difference scores indicate the extent to which phonological segmentation exceeds reading. Negative mean difference scores indicate the extent to which reading exceeds phonological segmentation.

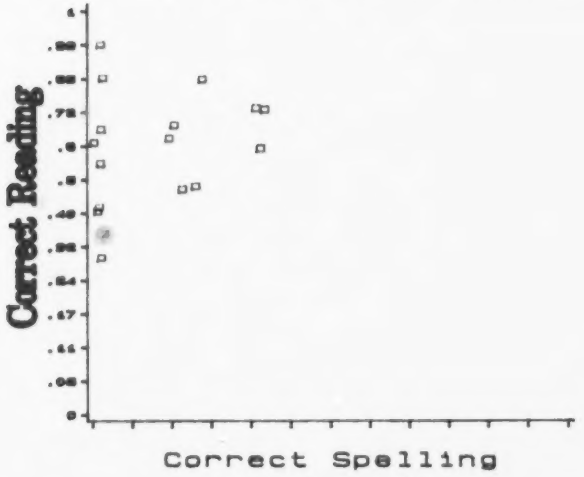
Figure Captions

Figure 1 Reading and spelling given segmentation response for exception words

Figure 2 Reading and spelling given segmentation response for regular words

Exception Word Performance in Grade 1

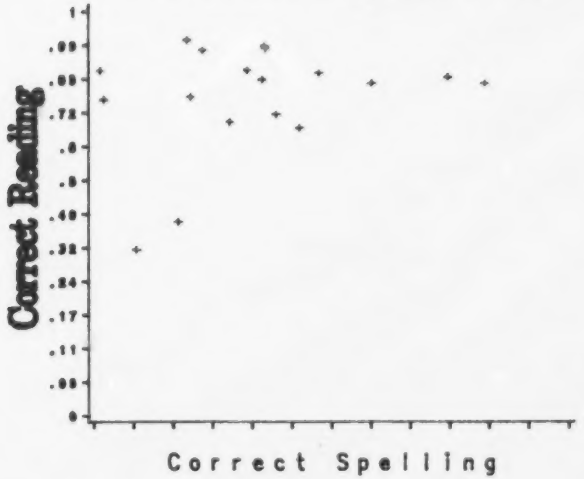
Incorrect Segmentation



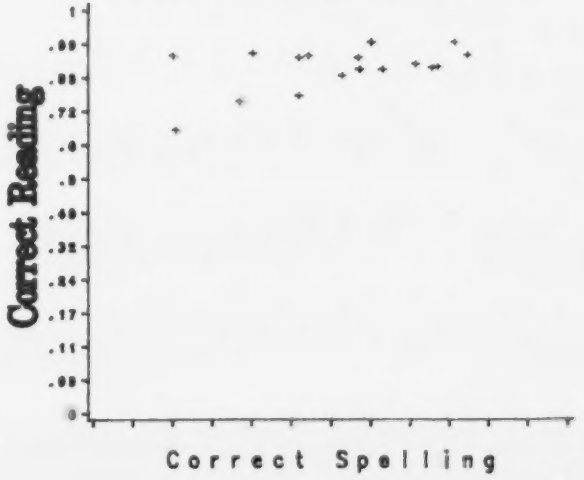
Correct Segmentation

Exception Word Performance in Grade 2

Incorrect Segmentation

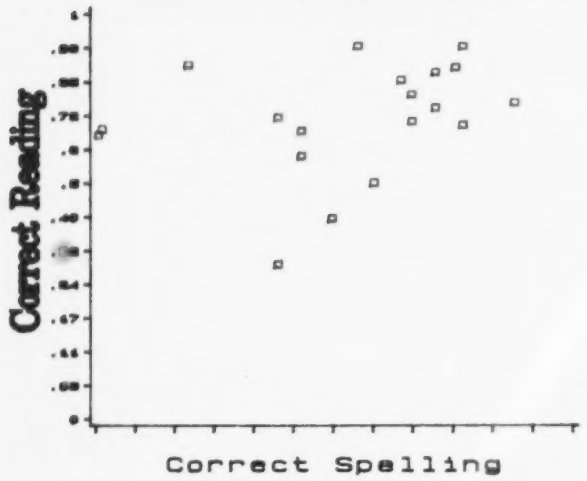


Correct Segmentation

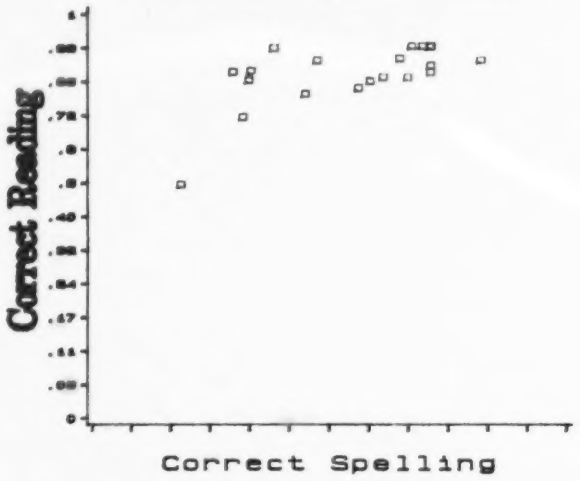


Regular Word Performance in Grade 1

Incorrect Segmentation

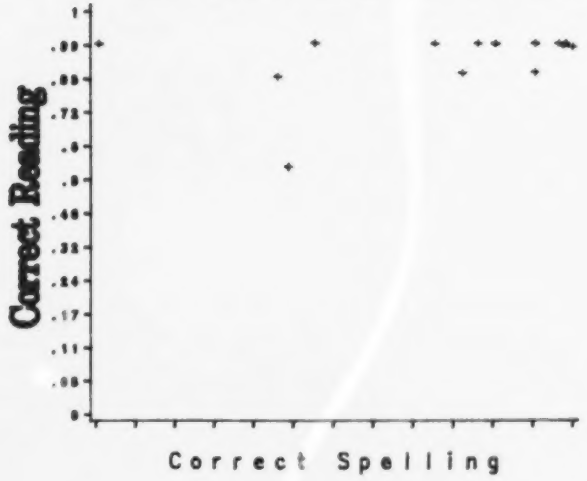


Correct Segmentation



Regular Word Performance in Grade 2

Incorrect Segmentation



Correct Segmentation